GEOGRAFICKÝ ČASOPIS

47 1995 3

*Ján Urbánek**

FLUVIAL RESPONSE OF LARGE LAND USE CHANGES (methodological study)

Ján Urbánek: Fluvial response of large land use changes (methodological study). Geogr. čas., *47*, 1995, 3, 9 figs., 23 refs.

Institute of Geography participates in international collaboration at the project "Fluvial response of large land use changes". The model area is the basin of the river Jablonka (163 km^2). The study outlines the system of steps that might lead to the solution of the problem. After the logical analysis a spatial analysis follows. It consists of several steps. It is a spatial analysis of the single variables entering into a causal relation (analysis of land use, analysis of large forms, analysis of topical processes). It is followed by spatial analysis of the proper causal relation i.e. relation between the areas of relevant change in land use and areas of relevant topical processes.

Key words: Fluvial system, geomorphological process, land use transformation, logical analysis, spatial analysis, geomorphological map.

INTRODUCTION

Institute of Geography participates in international collaboration coordinated by the Hebrew University, Jerusalem at the project "Fluvial response of large land use changes". The task of the Institute is to realize the field research in model territory. It is the basin of the river Jablonka with area of 163 km^2 situated prevailingly within the boundaries the Myjava hilly land. Smaller parts of the basin are located in the White Carpathians and the Little Carpathians.

* Geografický ústav SAV, Štefánikova 49, 814 73 Bratislava

Morphogenesis consists of numerous events. After the origin of the Pannonian planated surface (middle level) a phase of tectonic movements followed. In the period of relative tectonic tranquility the Plio-Pleistocene pediment (river level) originated. It was followed by another phase of tectonic movements. Pleistocene periglacial cycle was replaced in the Holocene by a humid cycle. These natural processes continued by the anthropogenic processes in the recent era. The outlined events represent the developmental scheme generally considered valid for the whole Slovak Carpathians (compare E. Mazúr 1964, 1965, 1976). Certain specific features appeared in the river basins of the Jablonka thanks to a heavy human impact (M. Stankoviansky 1994, 1995). This area was settled and agriculturally exploited since the 14th century. Traditional agricultural landscape originated and expanded over the majority of the area. It has been formed within the feudal, semifeudal and capitalist social structures. Agricultural soil was divided into numerous small lots, worked manually or with the help of animals. In mid 20th century the social and property relations changed. Tiny lots were joined into large fields. Heavy mechanisms and chemical means were used. The streams were regulated and dams constructed. This deep change in landscape use finished approximately in the 70-ties of the current century. Since then the structure of the landscape almost does not change. Agricultural landscape "persists" in the form imprinted to it by collectivization. A typical phenomenon in this landscape are intensive geomorphological processes on the slopes, flood plains and river beds. Research of the Jablonka basin occurs, as a part of the mentioned collaboration, in the light of certain hypothesis. It is an assumption that the reaction of the fluvial system to the changes in land use caused by the socialist collectivization was so important, as to acquire the nature of fluctuation. Then there is another assumption that the fluvial system responded as a system, that the change was total and not local. And finally an assumption that the fluctuation of the fluvial system lasts until the present time. The essential feature of the hypothesis is its relation to certain time and space, it has certain temporal and spatial dimensions.

This hypothesis leans on the facts, as well as on antecedent knowledge. It can be then considered well grounded (M. Bunge, 1956). After each rather heavy rain, storm or snow-thaw in many, above all in agriculturally exploited slopes intense erosional-accumulation processes can be observed. Muddy water flows in the flooding brooks. (These facts are described in more detail in the works of M. Stankoviansky 1988, 1994, 1995). The mentioned phenomena are generally (not only in the basin of Jablonka) interpreted as consequences of collectivization. Collectivization is attributed the very existence of these phenomena (given by the natural traits of the territory), but also its unusual intensity and frequency. This interpretation is generally accepted by the experts in various disciplines. It is almost impossible to say today who was the original author of this assertion. As a matter of fact this opinion of the consequences of collectivization is rather law than hypothesis.

We believe that we have run into one of the weak points of our, but not only our geomorphology. It is often a short trip from hypotheses about facts to laws. Hypotheses stimulating research are frequently abandoned in favour of generalized assertions that freeze the research. The aim of this study is to return the relation between the large scale land use changes and the fluvial system its status of hypothesis. We shall try to outline the single steps of the research mastered by this hypothesis, leading to its

confirmation or rejection. Our study was conceived as a methodological one. We deal with the research strategy and not the tactics of its single steps.

LOGICAL ANALYSIS

J. C. Hempel (1972) reproaches the empiric sciences that their notions are as a rule syntacticaly indetermined. Vague syntax of the notions is then a source of numerous misunderstandings and errors. Let us then try to express explicitly the syntax of our hypothesis. It contains two variables – land use system and fluvial system. It is assumed that these variables are connected by a causal relation, that the change of land use is the cause of the fluctuation of the fluvial system. It can be expressed by the formula:

R_c (L,F)

where

R_c – causal relations, L – land use system, F – fluvial system

This formula is only an elementary expression of the causal relation. Its drawback is analytical indefiniteness of its variables. The formula does not sufficiently express what the symbols Rc, L, F comprise. The purpose of the logical analysis is to remove this indefiniteness. For more on analytical indefiniteness see V. Filkorn (1960). Even the simplest causal relations is at least a three-member one (V. Filkorn 1960). Such relation in its general form is illustrated in Fig. 1. It can be easily applied also to our

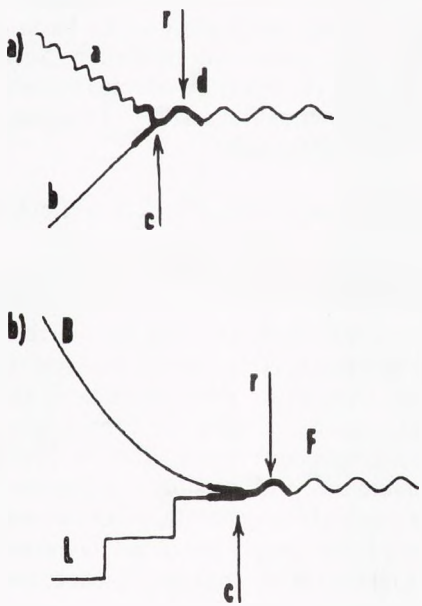

Fig. 1. Scheme of elementary causal relation.
a. Generally causal relation. a - process a, b - process b, d - changed process a, c - cause, r - effect.
b. Response of fluvial system. L - transformation of land use system proceeding in steps, B - long lasting trend of fluvial system, F - topical fluctuation of the fluvial system , c - cause, r - effect.

causal relation. Land use system is depicted as a process, transformation proceeding in jumps – traditional colonization, socialist collectivization. Fluvial system is projected also as a process. It is represented by a long lasting trend to graded state. The interaction of both processes causes that the fluctuation of the fluvial system lasts until the present day. This causal relation can be expressed by the formula:

Rc(/L, B/A)

Rc is causal relation, L is for transformation of land use system, B for long lasted trend of fluvial system and A stands for the present-day fluctuation of the fluvial system. In so conceived causal relation the fluvial system is divided into two parts – a long lasting trend (B) and topical fluctuation (A). The long lasting trend is a part of the cause, topical fluctuation is the effect. The Rc symbol denotes causal relation. This relation is an asymmetric one. It meas that it has two parts. A frontal and dorsal part. Analysis of the frontal part of the relation means the search for such traits of land use transformation and long lasting trend of fluvial system that participated in interaction ending in fluctuation of the fluvial system. Not all traits of land use transformation and long lasting trend of fluvial system can be *a priori* considered causes of fluctuation of the fluvial system. Relevant traits must be distinguished from irrelevant ones, viewed by causal relation. This part of analysis of the causal relation can be expressed by the formula:

/?L,B/, Rc (/L,B/A)

reading: which traits L,B enter the causal relation Rc?

Analysis of the dorsal part of the relation means the search for such traits of the contemporary processes that can be taken for fluctuation of the fluvial system. Not all topical geomorphological events taking place in the basin of the Jablonka can be *a priori* considered effects of socialist collectivization. Such topical events that are relevant from our point of view, i.e. are effects of collectivization, must be distinguished from irrelevant ones, outside our causal relation. This part of analysis of the causal relation can be expressed by the formula:

/?A/, Rc, (/L,B/A),

reading: which A enter the causal relation Rc, i.e. are effects of interaction of land use transformation and long lasting trend of fluvial system?

Also further steps of logical analysis should pursue the removal of analytical indefiniteness of causal relation. But here we run into the boundaries of the possibilities of logical analysis. Formal logic abstracts from the concrete time and space, it works only with abstract time and space. Nevertheless, concrete time and space are the key notions of our hypothesis. Even a very abstracted scheme shown in Fig. 1 reveals that several qualitatively different times enter our consideration. Land use changes by jumps. This time has a discontinuous, linear structure. Fluvial system shows another sequence. It changes continuously, irreversibly to a balanced state. Fluctuation that is interrupting it can mean a radical discontinuity, or can be contained as a mere episode. Layering of various times in the framework of the fluvial system was described by S. A. Schumm and R.W. Lichty (1965). The case of space, absent in the scheme of Fig. 1 is similar. Land use system is a discontinuous spatial form – network.

It is impossible to abstract from these concrete time-spatial structures inherent in the symbols Rc, L, B, A. These structures must be explicitly exposed. However, the

language of classical formal logic does not suffice here. We have to replace it by adequate language. In our opinion it is a map. Only the map language can adequately express the time-spatial syntax of our key notions.

SPATIAL ANALYSIS

Our aim is to know the temporal-spatial structure of land use system and the fluvial system, as well as the causal relation connecting it. We are trying to interpret the study area as an in time varying structure, eventually to prove that also in morphology Minkovsky's statement is effective: "Nobody has ever seen space without time and the contrary" (Wartofsky, M. W: 1968). However, the immediate experience with the terrain has other structure. Experience of space and experience of time are not symmetrically represented in it. Immediate experience of terrains is above all an experience of space. Immediate experience of time is fragmentary. It is only linked to the stay in terrain. Experience of longer periods is mediated by the experiences with space. Time is presented in certain spatial structure that is why the way to the knowledge of time-spatial structure is spatial analysis. It is spatial analysis of land use system, analysis of fluvial system and finally analysis of mutual relation.

Spatial analysis of land use system

The nature of land use system is that of mosaic. It is a mosaic of fields, forests, meadows, settlements, etc. Temporal dimension is mediated by two generations of aerial photographs. Spatial structure of land uses system can be expressed by a series of maps. They are basic maps, as well as more complex maps expressing various relations.

The contemporary land use can be identified from the topographical maps, but above all from aerial photographs. Mosaic depicted on aerial photographs can be easily interpreted as fields, meadows, forest, pastures, etc. It results in a comparably simple legend and the corresponding maps in the form of picture of mosaic. Map-mosaic expresses the spatial differentiation and similarity (Fig.2). It does not express any spatial connectivity and hierarchy. Map expresses a minimum temporal dimension. It expresses a current state at the time of mapping or photographing. Essentially this state lasts until today.

Traditional land use can be also identified from the maps and aerial photographs. Mosaic of aerial photographs can be interpreted to land use identification. It results in a map with identical legend like in the preceding case but the map depicts the elements of legend in other spatial constellation (Fig. 2). This map is also mosaic like the map of the contemporary land use. But it expresses an older stage with larger time dimension. Relation between the map of traditional and contemporary land use system is expressed by the map of transformation of land use system. Its legend consists of single types of transformation – change of the forest to field, of the field to pasture, etc. Result is a map in a form of mosaic, but depicting a pr ocess – transformation, instead of state.

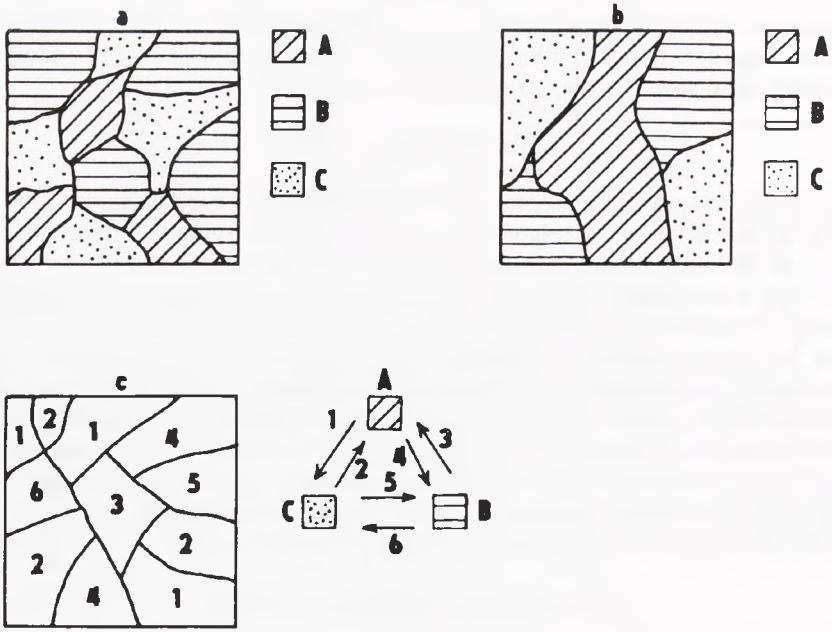

Fig. 2. Land use system.
a. Contemporary land use system. A, B, C. single forms of land use (forest, meadow, field, etc.)
b. Traditional land use system, A, B, C, single forms of land use (forest, meadow, field, etc.)
c. Transformation of traditional land use system to the contemporary one, A, B, C single forms of land use (forest, meadow, field, etc.)
Numbers one to six denote the single forms of transformation (forest to meadow, meadow to forest, etc.).

Spatial analysis of fluvial system

Fluvial system has different time-spatial structure from that of land use system. That is why its analysis must proceed in other way. Space of fluvial system is a hierarchically organized network. Organization of network is connected with organization of gravitational movement of material. Material is continuously displaced from the terminal parts of the network towards its mouth. It causes convergence of movement. Valleys of the first order are joined into valleys of second order, etc. Small forms are contained in larger ones. Fluvial system has also a temporal dimension. This is also given by gravitational material movement, a movement that lasts. Also the temporal dimension has a hierarchic structure as it manifests in spatial structure of the system. Various old forms lie one along other, one upon another or one is contained within another, etc. (Hierarchic structure of time and space of the fluvial system, its mutual links as well as their significance for causal relations were suggested some time ago by S. A. Schumm and R.W. Lichty 1965).

From the point of view of our problem in a hierarchically organized fluvial system there are important two levels. It is a difference separating the cause from the effect, a difference mentioned above. Level of topical events, that are (or can be) a fluctuation of fluvial system as an effect and the level of long lasting fluvial trend participating at

the cause. This difference can be expressed as a difference between the topical short-term process and the process characterized as a long-term trend and simultaneously as a difference between the small ephemeral form and large resistant form. Large resistant, slowly changing forms create some kind of background or heritage for the small ephemeral topical forms (Fig. 3).

Fig. 3. Relation of large and small from, eventually trend.
1 - large forms, eventually long-term trend or large cycle, 2 - small forms, eventually ephemeral events or small cycles. Lines 1 and 2 can be interpreted in two ways, in relation to space and in relation to time.

Spatial analysis of geomorphological background (large forms and long lasting processes)

Geomorphological background consists of large forms, large in horizontal and vertical dimensions. They are result of long, not finished development. Spatial analysis of large forms has two basic forms. It is typological analysis on one side and topological on the other. Corresponding maps represent the result. Fig. 4, 5, 6, 7, and 9 depict in a very simplified and idealized form the lower part of the Jablonka basin. They are above all conceptual models and not the maps of a concrete area.

Typological map is a result of classical geomorphological analysis it is an analysis of similarities. Forms are classified according to their similarity in shape, age, genesis, etc. Such classification creates a legend of the typological map (Fig. 4). Map depicts the localization of so classified forms. Meanwhile an important phenomenon of spatial repetition appears in the foreground. Each form of legend is repeated on the map, it becomes a type. If the legend comments the age and genesis of the forms then the map contains also an important time dimension. Typological analysis does not deal with the relations of neighbourhood between the forms. These spatial relations do not occur in the legend. Although they are expressed on the typological map by the boundaries separating single forms, these boundaries remain without interpretation.

Topological analysis analyzes the relation of neighbourhood between the forms. It analyzes how these forms neighbour (regardless whether they are or not similiar), how they compose larger forms, eventually how they compose smaller forms. It analyses spatial organization of these wholes, rate of their spatial continuity, centralization, etc. A phenomenon of spatial composition (Fig. 5) comes to the foreground. Though the relations of spatial neighbourhood or composition are equally evident in the terrain like the relations of spatial similarity, topological analysis and closely related topological map was paid much less attention than the typological analysis and its map (J. Urbánek, 1973, 1974, 1986, 1993). It is interesting that the topology or spatial relations are paid attention by the disciplines that are at the first glance very distant from geomorphology

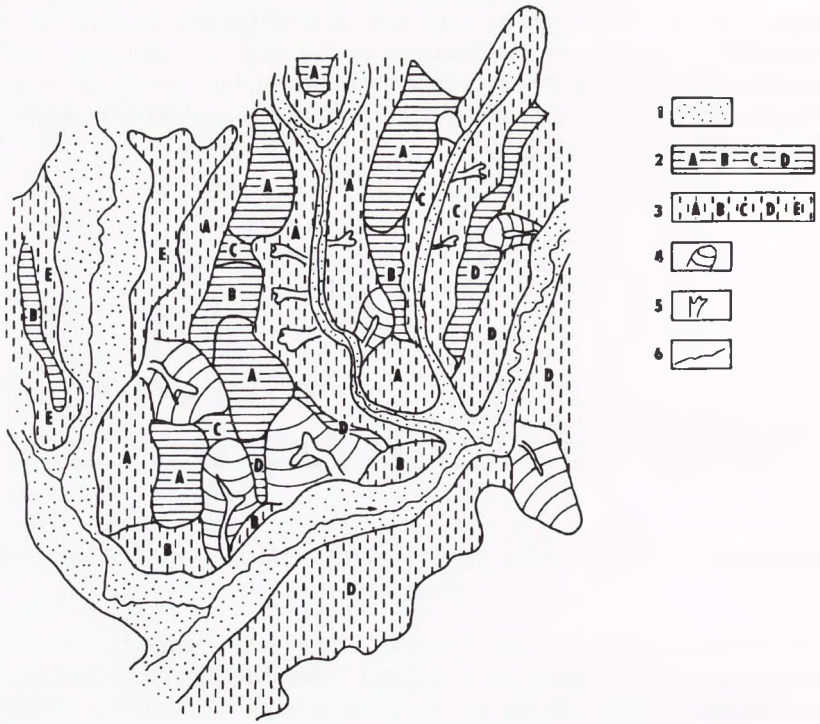

Fig. 4 .Geomorphological typological map.
1- flood plains, 2 - ridges,letters A, B, C, D denote types of ridges, 3 - slopes, leters A,B,C,D denotes types of slopes, 4 - large valleys, 5 - small valleys, 6 - water streams.

or geography. Thus, one of the basic features of structuralism is that the "places are superior to what occupies them" (G. Deluze, 1993). Interpreted by the language of geomorphology it means that the position of form given by spatial relations of neighbourhood is superior to its non-spatial, typological characters.

Spatial analysis of topical gemorphological events (small forms and ephemeral processes)

Topical geomorphological events create from the point of view of spatial and temporal dimensions some kind of "epidermis" on the geomorphological background. They are small forms in vertical and horizontal direction linked to short-term periodic or episodic processes. Spatial analysis of the topical geomorphological events has two forms, a typological and topological one. Typological analysis is the one of similarities and it is difficult anything to add. The result is a classification of the processes and the related forms well-known from the text books. They are processes (of creeping, splashing, overland flow, landslides, gullies, etc.) The results is a map depicting spatial distribution of these processes. Typological analysis in the contiguous area of the Jablonka basin in similar geomorphological conditions was done by M. Stankoviansky (1988, 1994).

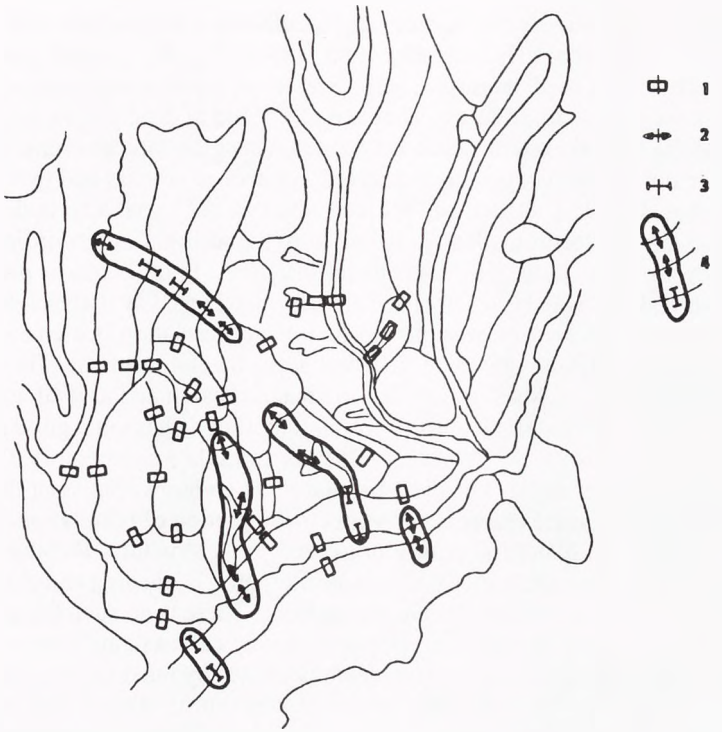

Fig. 5. Geomorphological topological map.
1 - uninterpreted contact of the neighbouring forms, 2 - positive contact (interaction) 3 - negative contact (barrier) 4 - chaining of the forms of larger wholes.

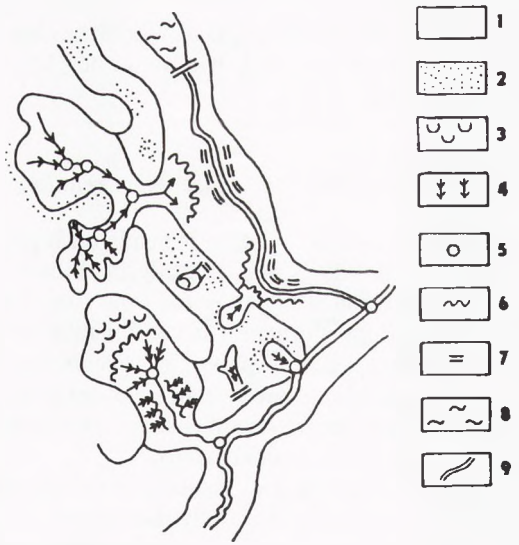

Fig. 6 . Topical geomorphological processes.
1 - areas without topical processes, 2 - topical processes without distinct spatial organization, 3 - slides, 4 - gullies, 5 - nodes, 6 - membranes, 7 - barriers, 8 - water reservoirs, 9 - water streams.

Topological analysis is the one of neighbourhood relations between the topical geomorphological events (J. Urbánek, 1986, 1993) (Fig. 6). Several types of basic spatial structure can be discerned. There exist areas without any topical processes, where there are no live small forms. They are some kind of dead places, gaps in topical structure of the fluvial system. There exist areas where the topical events are evident. But they are not distinctly spatially organized. An area of erosion and that of accumulation are not distinctly discerned. We can observe only spatially undifferentiated material movement: forms evidently distinct from the surrounding environment do not origin. They are some kind of difused spatial structures. In other places processes and forms organized into catenas occur. They are organized in a way that enables a distinct differentiation of the area of erosion and that of accumulation. Catena as a form is distinctly innerly differentiated and different from its environment. There are three basic types of catenas. Closed catena has an area of erosion and area of accumulation connected by asymmetrical relations of correlation. Catena has got a good memory. In its sediments the history is well recorded. But it is a strictly local memory. Open catena leases a part of the material "outside", beyond its boundaries. Between the erosional area and accumulation area there is no symmetrical relation of correlation. Memory of catena is weaker. Its history is poorly preserved in its structure. Pulsing catena is a combination of an open and closed one. It is an alternatively opening and closing catena.

The mentioned types of catenas are abstractions. There is no such thing as completely and forever closed catena. The open and pulsing catenas anticipate certain environment, they are open to. If this environment is created by other catenas, then we have a network of catenas. The network consists of a group of catenas that are mutually interacting and overlapping. At the spatial composition of the network there are various important places of a point or line character – the nodes of the barriers, membranes. Node is a place where several catenas open to themselves. It is a place where the spatial interaction slows down the transport of material. Membrane is a place where catenas alternatively open and close to themselves, a place, where the character of the transport is that of pulses (Fig. 6). Similar approach was suggested by M. Lehotský (1994) concerning the catena of Rudník.

Spatial analysis of the cause-effect relation

Spatial analysis of the cause-effect relation depends on logic of above described causal relations. It consists of two steps. It is an analysis of the frontal and analysis of the dorsal part of the causal relation. To analyze the front part of the relation means to investigate whether the land use transformation in combination with geomorphological background is the cause of topical geomorphological events. In other words it means to look for the relevant changes in land use system (relevant from the point of view of the topical events) and to exclude the irrelevant changes. Not every change in land use system is necessarily the cause of the topical events.

The map of land use transformation itself anticipates certain causal relations. Thus the change of the forest to arable land is generally interpreted as a stimulus for topical events. The reverse change is interpreted in opposite way, etc. This implicit map contents must by expressed explicitly and the single fields of the map must be aligned

the characters of the stimulus, eventually those of obstacles. Typological map anticipates natural instability, eventually the stability of forms. This implicit feature must be introduced in the map.

Topological map anticipates the natural instability eventually stability of localities. Also this feature must be introduced in the map.

These maps can be connected to one, legend of which can be expessed by predicate calculies (Fig.7). This map shows the spatial distributions of supposed causes of topical events. The comparision of distribution of topical events will show the nature

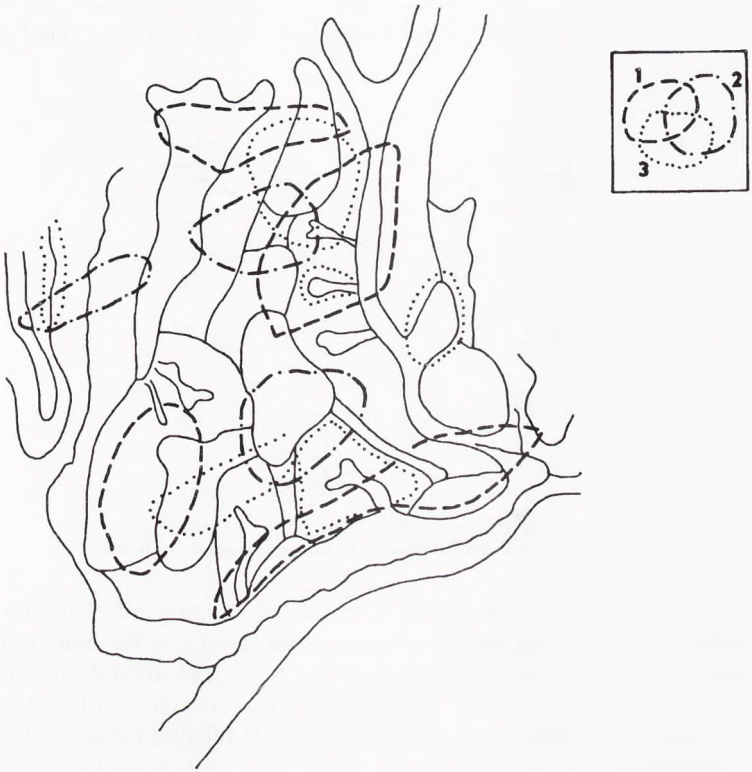

Fig. 7. Spatial distribution of causes.
1 - areas unstable from the typological point of view, 2 - areas unstable from topological point of view, 3 - areas of relevant transformation of land use system.

of supposed causal relation. Only topical events located in area of relavant land use transformation can be considered us effects of it. But not all of them must represent fluctuation of the whole fluvial system.

Analysis of the dorsal part of the relation means searching for relevant topical events, i.e. those that have a nature of complete fluctuation of the fluvial system. There are, as a matter of fact, events that do not have these feature, and therefore irrelevant for us.

The first step is to find out whether the contemporary processes have a character of fluctuation or whether they represent a continuation of long-term developmental trends

inherited from older stages. This relation can have four basic forms. The old form can be perfectly conserved. It does not contain any younger, small forms. Other relation is well expressed by the German term "Traditionelle Weiterentwicklung" (H. Bremmer 1980). Inherited old form is alive but it is modelled by the topical processes in a way that enables it to preserve the original form (Fig. 8). In this case there is either no fluctuation or it is a hidden fluctuation that manifests itself in distinct forms. This type of fluctuation must be counted on in the Jablonka basin. On periglacial dell-like forms there can be created younger dell-like forms as result of the effects of the contemporary non-periglacial processes. Complex changes in dynamism, changes of fluctuating nature can occur in the background of the traditional softly modelled relief disguising these events.

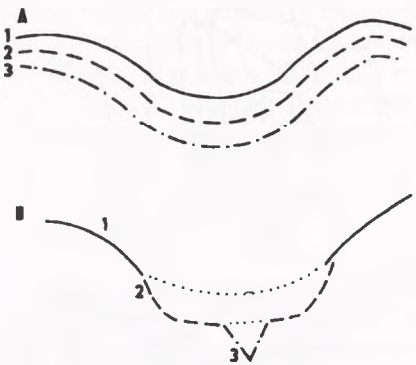

Fig. 8. Time-spatial relations between generations of the forms.
A. Traditionelle Weitebildung, B. Einschachtellung. 1,2,3 - generations of forms.

The third relation is very well expressed by other German word: "Einschachtelung" (H. Bremmer 1989) meaning that the younger form is put into the older one (Fig. 8). Such younger form appears beside the older as a foreign element destroying it. As a rule this relation manifests itself as on the borderline between the older and younger form appearing of an alive, moving edge. Such spatial relation means certain fluctuation in the development of relief. Finally, the old forms can be perfectly up-dated, completely destroyed by younger forms. In this case it can be a disguised fluctuation. Fluctuation is disguised by the absence of older forms.

Analysis of the relation between the large old forms and young small forms allows differentiation of the contemporary processes that have nature of fluctuation. Only those processes confirm our basic hypothesis.

The second step is analysis of the relation between the topical events and typological map (Fig. 4). The immediate study of the topical events on the whole study area is impossible. Topical events can be adequately studied only in certain model areas. Besides the topical events also the link between them and the geomorphological types must be observed. And above all those events are relevant that are linked to certain type that allows assumption that they would frequently repeat together with this type in the terrain, they become the part of the type. Their relevancy lies precisely in the

presumed abundant occurrence. The following step is an analysis of relation between the topical events and topological map (Fig. 5). Topical events in their typological form should be projected in a topological map in order to situate them. It means distinguishing whether they have peripheral or central positions. Those topical events, material of which remains "hanging" on the slopes or spring areas of the valleys, have peripheral position. The material does not penetrate in the flood plain or beds of the streams of higher order. Topical events that imply the possibility of the material transported by them to get even to the streams of higher order, eventually to leave the basin have a central position. Only these topical events affect the basin as a system, they are a complete fluctuation.

The quoted three maps can be integrated into one, a map of relevant topical events. It legend can be expressed by the predicate calculus (Fig. 9). Relevant topical events are situated at the intersection of all three classes. They are topical events representing the fluctuation, they form a part of gemorphological types and are of complete nature. Analysis of causal relation is the spatial analysis of the relation between the map of distribution and a map of relevant topical events. If our basic hypothesis is correct, then the relevant topical events will concenrate at the areas of the causes.

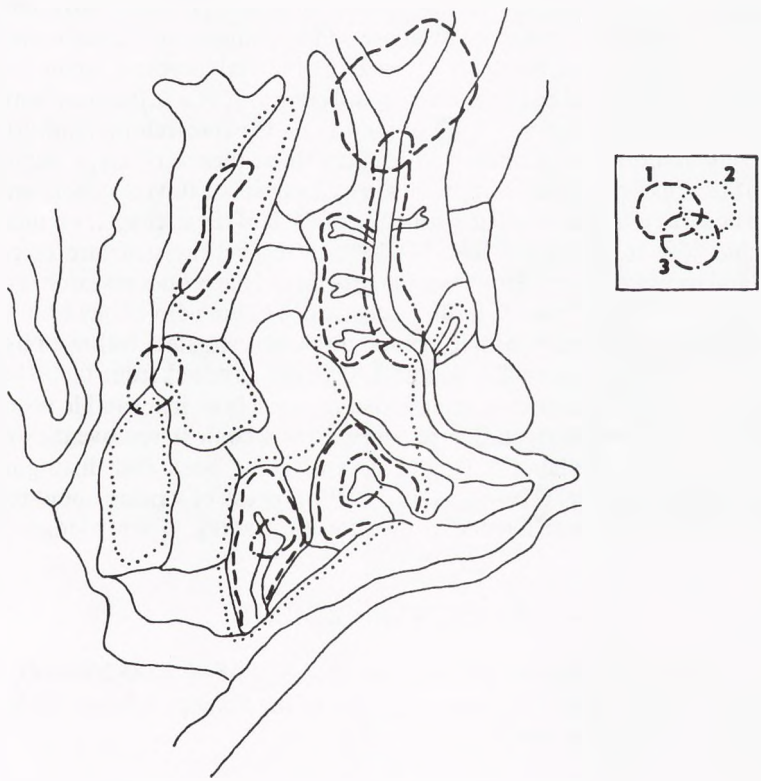

Fig. 9. Relevant topical processes.
1 - topical processes of fluctuation nature, 2 - typologically relevant topical processes,

Other spatial relations between the relevant topical events and relevant land use transformation will cast doubt over the basic hypothesis. But the doubt over the hypothesis (if we eliminate the possible errors while evaluating the relevant land use transformation and relevant topical events) does not have to be necessarily purely negative phenomenon. On the background of questionable hypothesis of fluvial response of large scale land use changes an opposite hypothesis may emerge. It can be called hypothesis of metastability of the fluvial system (For the concept of metastability see E. Jantsch 1986). It can be briefly formulated as follows: We can assume that at the background of numerous topical geomorphological events there is a stable system. Numerous intensive erosion-accumulation processes on the slopes, flood plains and beds are compensated and the fluvial system as a whole behaves as a metastable system. If we investigate basin within the framework of small time-spatial dimensions, then it appears as very unstable, as "full" of local topical events. The same basin investigated from the point of view of larger time-spatial dimensions appears as stable, eventually metastable. This metastability was not impaired even by the distinct change of land use system in the period of the socialist collectivization. It is possible that the mentioned omnipresent softly modelled relief erasing the boundaries between the neighbouring forms just like between the younger and older forms is a manifestation of metastability. It would be probably useful to do the whole research in the light of the two contradicting hypotheses -- hypothesis on fluvial response and hypothesis on fluvial metastability. We have tried to outline methodology of research of fluvial response. At the conclusion we would like to emphasize one important difference. It is a difference between the logic of the proper research and logic of writing on the research method. Method of research was described as a linear and irreversible sequence of steps beginning by analysis of land use transformation, continue by analysis of fluvial system and end by analysis of causal relation, while the structure of each of these chapters would be also linear. Other way is hardly possible. We have to respect the structure of colloquial language and its written form. However, the structure of the proper research is different. Research can start at any "point". It can be developed in both directions from the cause to the effect and the contrary. Single causes can be investigated, followed by investigation of their interaction, ending in effect. One can proceed from the effect of the single causes. The most important thing is that research is an irreversible process. One has to go back to the single steps, interpret them in new context, remove the drawbacks of the preceding interpretations. This process of going back that distinguishes the research for the real causal relation, as well as the process of writing about research is a typical feature of the intelligence of the process, leading to knowledge (J. Piaget 1966).

ACKNOWLEDGEMENT

This research was supported under Grant No. HRN-5544-6-00-2060-00, Program in Science and Technology Cooperation, Office of the Science Advisor, U.S. Agency for International Development.

LITERATURE

BUNGE, M. (1956). *Scientific Research I.* Berlin-Heidelberg-New York. (Springer Verlag).

BREMMER, U.H. (1989). *Allgemeine Geomorphologie.* Methodik-Grundvorstellungen-Ausblick auf den Landschaftshaushalt. Berlin-Stuttgart (Gebrüder Bornträger).

DELUZE, G. (1993). *Podľa čoho poznáme štrukturalizmus?* Bratislava (Archa).

FILKORN, V. (1960). *Úvod do metodológie vied.* Bratislava (SAV).

HEMPEL, J.C. (1972). Fundamentals of Concept Formation in Empirical Science. *International Encyklopedia of Unified Science* Chicago (University of Chicago Press).

JANTSCH, E. (1986). *Die Selbstorganization des Universums.* München (Deutschen Taschenbuch Verlag).

LEHOTSKÝ, M. (1994). Spatial distribution of real and potential nodes and ways of delivery of water and material from slopes into water courses. In Stankoviansky, M. et al. Annual Report *The Response of Fluvial Systems to Large Scale Land Use Changes.* Interná štúdia, Geografický ústav SAV, Bratislava.

MAZÚR, E. (1964). Intermountain Basins-Characteristics Element in the Relief of Slovakia. *Geografický časopis*, 16, 105-126.

MAZÚR, E. (1965). Major Features of the West Carpathians as a result of Young Tectonic Movements. In Mazúr, E., Stehlík, O., ed. *Geomorphological Problems of Carpathians.* Bratislava (SAV), pp. 9-54.

MAZÚR, E. (1976). Morphostructural Features of the West Carpathians, *Geografický časopis*, 28, 101-111.

PIAGET, J. (1966). *Psychológia inteligencie.* Praha (Svoboda).

SCHEIDEGGER. A.E. (1986). The catena principle in geomorphology. *Zeitschrift für Geomorphologie,* 30, 257-273.

SCHUMM, S.A., LICHTY, R.W. (1965). Time Space and Causality in Geomorphology. *American Journal of Science*, 263, 110-119.

STANKOVIANSKY, M. (1988). Exogénne reliéfotvorné procesy modelového územia Bzince pod Javorinou (Biele Karpaty). *Sborník československé geografické společnosti*, 93, 9-19.

STANKOVIANSKY, M. (1994). Hodnotenie reliéfu povodia Vrzávky so zvláštnym zreteľom na jeho súčasnú modeláciu. *Geografický časopis*, 46, 267-282.

STANKOVIANSKY, M. (1994). Relief Myjavskej pahorkatiny a vývoj jeho modelácie v holocéne. Geographia Slovaca 7, pp. 155-162.

STANKOVIANSKY, M. (1995). Report of the Slovak investigators of the project "The Response of Fluvial System to large Scale Land Use Changes". Interná štúdia, Geografický ústav SAV, Bratislava.

STANKOVIANSKY, M. (1995). Hodnotenie stružkovej erózie vyvolanej roztopovými vodami (na príklade vybranej časti Myjavskej pahorkatiny). In Trizna, M. ed. *Vybrané problémy súčasnej geografie a príbuzných disciplín.* Bratislava (PFUK), pp. 81-88.

URBÁNEK, J. (1973). Pokus o interpretáciu geomorfologického tvaru. *Geografický časopis,* 25, 6-26.

URBÁNEK, J. (1974). Niekoľko poznámok ku klasifikácii geomorfologických tvarov. *Geografický časopis,* 26, 16-41.

URBÁNEK, J. (1986). Geomorfologické pomery Bestín a priľahlej časti Bošáckych bradiel. *Geografický časopis*, 41, 274-292.

URBÁNEK, J. (1993). Princíp katény v geomorfológii. *Geografický časopis*, 45, 197-212.

WARTOFSKY, M.W. (1968). *Conceptial Foundation of Scientific Thought.* New York-London (Wiley and Sons).

Ján Urbánek

REAKCIA FLUVIÁLNEHO SYSTÉMU NA VEĽKOPLOŠNÉ ZMENY VO VYUŽÍVANÍ KRAJINY (metodologická štúdia)

Geografický ústav SAV sa v rámci medzinárodnej spolupráce podieľa na riešení problému

"Reakcia fluviálneho systému na veľkoplošné zmeny vo využívaní krajiny". Problém sa rieši na modelovom území povodia Jablonky, ktoré má rozlohu 163 km^2 a leží prevažne v Myjavskej pahorkatine.

Výskum sa deje vo svetle určitej hypotézy, ktorú možno formulovať takto: Predpokladá sa, že reakcia fluviálneho systému na zmeny vo využívaní krajiny spôsobené socialistickou kolektivizáciou bola taká silná, že mala charakter fluktuácie. Ďalej je to predpoklad, že na zmeny reagoval celý fluviálny systém a nešlo iba o lokálnu reakciu. Cieľom štúdie je načrtnúť systém krokov, ktorý povedie k potvrdeniu, alebo vyvráteniu tejto hypotézy.

Logická analýza ukazuje, že uvedená hypotéza má štruktúru trojčlenného kauzálneho vzťahu, ktorý možno vyjadriť formulou $R_c(/L,B/A)$. R_c označuje kauzálny vzťah, L transformáciu využitia krajiny, B prirodzený dlhodobý trend fluviálneho systému, A označuje aktuálne procesy fluviálneho systému. Formulu treba čítať takto: interakcia dlhodobého trendu fluviálneho systému (B) so zmenou vo využívaní krajiny (L) zapríčinila aktuálnu fluktuáciu fluviálneho systému (A). Overiť, či tento hypotetický kauzálny vzťah platí, možno iba priestorovou analýzou povodia.

Tradičné využitie zeme možno identifikovať z topografických máp a leteckých snímok a vyjadriť ho v mape, ktorá má podobu mozaiky. Zo starších máp a snímok možno identifikovať tradičný spôsob využitia krajiny a tiež ho vyjadriť mapou. Vzťah oboch máp možno vyjadriť mapou vlastnej transformácie využitia krajiny. Je to tiež mapa v podobe mozaiky. Jej legendu tvoria jednotlivé typy transformácie (plocha, kde sa zmenil les na pole, pasienok na les, atď.). Prirodzený dlhodobý trend fluviálneho systému je reprezentovaný veľkými formami zdedenými z minulých etáp geomorfologického vývoja. Tieto formy sú vyjadriteľné v dvoch mapách. Je to klasická typologická mapa, vyjadrujúca podobnosti foriem tvaru, veku, genézy a pod. Druhou mapou je topologická mapa. Vyjadruje priestorovú organizáciu foriem, mieru ich priestorovej kontinuity, vzťahy susedstva a pod. Aktuálne geomorfologické procesy sú reprezentované malými efemérnymi formami, ktoré na veľkých z minulosti zdedených formách tvoria akúsi "epidermu". Tieto procesy treba na mape vyjadriť ako geomorfologické katény, t.j. na základe ich priestorových väzieb, podľa toho ako sa skladajú do väčších organizovaných celkov.

Priestorová analýza vlastného vzťahu sa skladá z niekoľkých krokov. Prvým krokom je hľadať tie zmeny vo využívaní krajiny, ktoré sú relevantné z hľadiska aktuálnych geomorfologických procesov a mohli sa podieľať na kauzálnom vzťahu. Samotná mapa transformácie využívania krajiny anticipuje niektoré príčinné vzťahy (zmena lesa na oráčinu, odstránenie medzí a pod.). Tento implicitný obsah mapy treba vyjadriť explicitne. Typologická mapa anticipuje prirodzenú labilitu foriem. Topologická mapa anticipuje prirodzenú labilitu lokalít. Takto prehodnotené mapy možno spojiť do jedinej. Jej legenda bude mať formu predikátového kalkulu. Mapa ukazuje kde sa prekrývajú relevantné zmeny vo využívaní krajiny s prirodzenou labilitou veľkých foriem. Táto mapa anticipuje rozmiestnenie aktuálnych procesov.

Druhým krokom je hľadať relevantné aktuálne procesy a odlíšiť ich od nerelevantných. Nie každý aktuálny proces musí byť fluktuáciou. Niektoré aktuálne procesy môžu byť pokračovaním prirodzeného vývoja bazénu. Ďalej treba stanoviť vzťah medzi aktuálnymi procesmi a typologickou mapou. Relevantné sú tie procesy, ktoré sa viažu na určitý typ, a teda sa mnohonásobne opakujú. Vzťah aktuálnych procesov k topologickej mape odhalí ich ďalšiu relevantnú črtu. Relevantné sú centrálne lokalizované procesy, t.j. procesy, ktoré transportujú materiál, ktorý sa dostáva na nivy, či dokonca do tokov vyššieho radu. Uvedené tri vzťahy možno vyjadriť jedinou mapou, ktorá vyjadruje lokalizáciu relevantných aktuálnych procesov, t.j. procesov, ktoré sú fluktuáciou, súčasťou geomorfologického typu a majú celostný charakter.

Ak je východisková hypotéza správna, potom sa relevantné aktuálne procesy budú koncentrovať do oblastí relevantných zmien vo využívaní krajiny. Opačné priestorové vzťahy by potvrdzovali opačnú hypotézu. Možno ju formulovať ako hypotézu o metastabilite fluviálneho systému. Táto hypotéza predpokladá, že na pozadí početných aktuálnych procesov jestvuje stabilný geomorfologický systém a fluktuálne procesy sa kompenzujú, takže základný, celostný charakter povodia sa nemení ani vplyvom zmien vo využívaní krajiny.

Text k obrázkom:

Obr. 1. Schéma elementárneho kauzálneho vzťahu.

a. Všeobecne kauzálny vzťah. a. - proces a, b - proces b, d - zmenený proces a, c - príčina, r - účinok.

b. Reakcia fluviálneho systému. L - skokmi prebehajúca trabsformácia využitia zeme. B - dlhodobý trend fluviálneho systému, F - aktuálna fluktuácia fluviálneho systému, c - príčina, r - účinok

Obr. 2. Systém využitia krajiny.

a. Súčasné využitie krajiny. A.B.C. jednotlivé formy využitia krajiny (les, lúka, pole, atď.).

b.Tradičné využitie krajiny. A,B,C jednotlivé formy využitia krajiny (les, lúka, pole, atď.).

c. Transformácia tradičného land use systému na súčasný.

A,B,C. jednotlivé formy využitia krajiny (les, lúka, pole, atď.). Čísla jedna až šesť označujú jednotlivé formy transformácie (les na lúku, lúka na les, atď.).

Obr. 3. Vzťah veľkých a malých foriem, resp. trendov.

1 - veľké formy, resp. dlhodobý trend či veľký cyklus, 2 - malé formy, resp. efemérne udalosti či malé cykly. Línie 1 a 2 možno interpretovať dvojako, jednak vo vzťahu k priestoru, jednak vo vzťahu k času.

Obr. 4. Geomorfologická typologická mapa.

1 - nivy, 2 - chrbty, písmená A,B,C,D označujú typy chrbtov, 3 - svahy, písmená A,B,C,D,E označujú typy svahov, 4 - veľké doliny, 5 - malé doliny, 6 - vodné toky.

Obr. 5. Geomorfologická mapa topologická.

1 - neinterpretovaný kontakt susediacich foriem, 2 - kontakt pozitívny (interakcia), 3 - kontakt negatívny (bariéra), 4 - zreťazenia foriem do väčších celkov.

Obr. 6. Aktuálne geomorfologické procesy.

1 - územia bez aktuálnych procesov, 2 - aktuálne procesy bez výraznej priestorovej organizácie, 3 - zosuny, 4 - výmole, 5 - uzly, 6 - membrány, 7 - bariéry, 8 - vodné nádrže, 9 - vodné toky.

Obr. 7. Relevantná transformácia využitia krajiny.

1 - územia labilné z typologického hľadiska, 2 - územia labilné z topologického hľadiska, 3 - územia relevantnej transformácie využitia krajiny.

Obr. 8. Časopriestorové vzťahy medzi generáciami foriem.

A. Tradične prebiehajúci vývoj (Traditionelle weitebildung). B. Rozčleňovanie starších foriem mladšími (Einschatellung). 1,2,3 - generácie foriem.

Obr. 9. Relevantné aktuálne procesy.

1 - aktuálne procesy charakteru fluktuácie, 2 - typologicky relevantné aktuálne procesy, 3 - topologicky relevantné aktuálne procesy.